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EDITORIAL

INSPECTION AND CONTROL OF FOODS OF ANIMAL ORIGIN

If man ceased to consume food of animal origin there would be little need to devote much time or energy to those matters which are embraced by the term animal husbandry.

There can be no doubt that the animals of the farm play a role in preserving and enhancing the fertility of the soil, but in these days when science is harnessed to the service of agriculture no doubt alternative methods of achieving this aim may one day be accomplished. The care of farm stock is a consuming one in time, labour and finance and the effort is justified only when the return is adequate.

In the golden days of the horse, breeding of animals for sale was an important factor in the economy of the farm. Many small farmers were able to provide for their own transport and, by sales of mature animals each year, earn enough money to pay their rent. This great industry depended basically upon the production of the draft animal which was harnessed to the commercial cart or van. The show specimen, whilst it had a great and beneficial influence on the improvement of stock, particularly as regards conformation, had little effect upon the general economy of the ordinary farm. The present dire state of the horse-breeding industry and population is a striking example of what can happen when a finished product ceases to command an adequate commercial return.

(The June issue of The British Veterinary Journal was published on June 1)

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The same state of affairs could occur as regards the food-producing animals if by accident or design scientists were to discover alternative methods of providing the people with protein of a nutritive value and palatability equal to that derived from animals.

Such remarks may seem fantastic but many things of equal wonder have come to pass in the last few decades. Attempts have been made to produce "synthetic milk"; had they been successful, and in the light of modern chemical knowledge no one can say that the task is an impossible one, the great dairying industry would have received a mortal blow.

As the working horse was the mainspring of horse breeding so do the food products of animal origin provide the impetus for other forms of animal husbandry. The production of great quantities of protein of animal origin would be valueless if some equivalent substances were available commercially.

The market is provided by the consumer and he is entitled to expect that his food shall be nutritious and wholesome. Veterinary surgeons devote much attention to the care and management of the food-producing animals whilst they are on the farm, but except for the efforts of a few, the terminal product destined for the table is almost completely ignored.

What is the use of producing a grade one product if the article is to suffer deterioration after it leaves the farm? If we ignore or neglect this stage we are not keeping faith with the consumer, for he has the right to expect that his food shall be under constant supervision and care, on the farm and through all its phases until it reaches his table.

Veterinary surgeons are the only people who can implement the consumer's requirements at all of these stages. The few who have devoted their lives to the terminal stages of this process have done a good job; they have accumulated a great store of knowledge, and they have justified fully the above contention.

All that is required now, and the matter is urgent and the time appropriate, is more support from the profession at large. If that support be given enthusiastically the field of endeavour can be greatly enlarged to the lasting benefit of the public and, incidentally, of the profession.

GENERAL ARTICLES

JOHNE'S DISEASE

By T. M. DOYLE

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IT has long been known that varying degrees of cross-protection occur between the different members of the pathogenic acid-fast group of organisms. Von Behring (1902) showed that strains of human tubercle bacilli afforded considerable protection against bovine tubercle bacilli.

M'Fadyean, Sheather, Edwards and Minett (1913) stated that the intravenous inoculation of avian tubercle bacilli conferred on calves a markedly increased power of resistance to infection with bacilli of the bovine type. M'Fadyean and Sheather (1916) attempted to confer protection against Johne's bacilli with tubercle bacilli. Three yearling cattle were inoculated intravenously with 30 mg. human tubercle bacilli and later they were given 25 mg. of bovine bacilli subcutaneously. Seven months after the second inoculation the vaccinated cattle and five controls, four aged six months and one aged nineteen days, were each inoculated intravenously with 50 mg. of culture of *M. johnei*. The animals were submitted to post-mortem examination six to ten months later. No evidence of Johne's disease was found in the three animals inoculated with tubercle bacilli, but three of the five controls were infected. The authors stated that the results might be held to afford evidence that the previous inoculation with tubercle bacilli conferred some protection against Johne' disease, but that the number of experimental animals was too small to justify any conclusions. Wells and Brooks (1940) showed that the vole acid-fast bacillus conferred a marked degree of protection on guinea-pigs against subsequent tuberculous infection. B.C.G. vaccine, consisting of an attenuated strain of bovine tubercle bacilli, confers considerable resistance against both human and bovine tubercle bacilli.

Present Investigation

The purpose of the experiments here described was: (1) to determine whether Johne's bacilli would afford any protection against bovine tubercle bacilli; (2) to ascertain the effect on tuberculin tests of superimposing infection with bovine tubercle bacilli on animals vaccinated against Johne's disease.

Record of Experiments

Twenty-eight goats, 12 weeks of age, were tested with mammalian and avian tuberculins. None reacted. Fourteen of the goats were each inoculated subcutaneously in the neck with 2 c.c. Johne's disease vaccine (Vallée-Rinjard vaccine); all developed vaccinal nodules. Each dose of vaccine contained 5 mg. of moist culture (growth pressed between sheets of sterile filter paper) of Johne's bacilli, 10 mg. powdered pumice stone, and 1 c.c. each of sterile liquid paraffin and olive oil. Goats were used in preference to calves because there was little risk of them contracting tuberculosis through the ingestion of milk.

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Infection with Bovine Tubercle Bacilli

As the protection, if any, conferred by Johne's bacilli against bovine tubercle bacilli was likely to be small, it was essential that the test dose of tubercle bacilli should not be administered by a route that would cause a rapid and severe type of infection. Intravenous inoculation was on this account ruled out. Infection by the oral route, used by Griffith and Dalling (1940) failed, in our hands, to infect some heifers. Having considered the various routes of infection it was decided to instil the test dose into the conjunctival sac. Inoculation of bovine tubercle bacilli by this route to guinea-pigs causes a progressive infection, starting in the glands of the head and slowly extending to those of the thorax and abdomen.

Test Suspension

Six strains of bovine tubercle bacilli were grown for 14 days on Reid's synthetic medium; the growths were collected, mixed in equal proportions and pressed between sheets of sterile filter paper. The mass of growth was mixed for four hours in a revolving flask with agate balls. It was suspended in buffered saline so that each drop contained approximately 0.05 mg. Three months after vaccination the fourteen goats with twelve controls were each given five drops of the test suspension into both conjunctival sacs. Purulent conjunctivitis of varying severity occurred in four goats following the instillation of the tubercle bacilli. Three of the control goats showed considerable swelling and ulceration of the parotid glands and one goat developed infection of the meibomian glands (see photographs).

Post-mortem Examination of Goats

The vaccinated goats and controls were divided into four groups and post-mortem examinations were made at intervals of five, eight, eleven and twenty months, respectively, after the administration of the infective dose of tubercle bacilli.

It will be seen from Table 1 that no vaccinated goat was sufficiently protected to resist completely infection with tubercle bacilli. In three of the four groups the aggregate of tuberculous lesions was considerably less in the vaccinated goats than in the controls, but the longer the intervals between the test dose of tubercle bacilli and post-mortem examination the more extensive were the lesions. In some of the vaccinated goats the lesions were trivial, but all had tubercle bacilli in at least one lymphatic gland and these would have unquestionably caused a progressive infection as the vaccinal protection waned. In groups I and II, examined post-mortem five and eight months after the infective dose, there was a marked difference in the extent and severity of the lesions between the vaccinated goats and the controls. In groups III, examined eleven months after the infective dose, lesions in the vaccinated goats were considerably less than in the controls. In group IV, examined twenty months after the infective dose, severe and extensive tuberculous lesions were present in two of the vaccinated goats and these were as severely infected as the two controls.

FIG. 1

CONTROL GOAT.—Swelling and ulceration of parotid lymph gland.

FIG. 2

CONTROL GOAT.—Swelling of both parotid lymph glands and also of the meibomian glands.

(Article by Doyle, page 275)

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TABLE I

Post-mortem Examination of Goats

Group I. Five months after the infecting dose of tubercle bacilli.

V. Goat. 1434. One submaxillary gland and one pharyngeal gland slightly diseased. Both parotid glands moderately affected.

V. Goat. 1433. Both pharyngeal glands contained several small tubercles.

V. Goat. 1435. One submaxillary gland slightly diseased. Parotid and pharyngeal glands contained several small tubercles.

C. Goat. 1451. Died, four months after infecting dose, of severe generalised tuberculosis.

C. Goat. 1424. Pharyngeal, submaxillary and parotid glands enlarged and contained numerous tubercles.

C. Goat. 1455. Pharyngeal, submaxillary and parotid glands enlarged and extensively diseased. Thoracic gland slightly affected.

Group II. Eight months after infecting dose of tubercle bacilli.

V. Goat. 1461. Pharyngeal, submaxillary and parotid glands enlarged and contained numerous tubercles. Thoracic and hepatic glands moderately diseased.

V. Goat. 1454. Parotid and pharyngeal glands slightly affected.

V. Goat. 1459. Parotid, submaxillary and pharyngeal glands slightly affected.

C. Goat. 1462. Died, eight months after infecting dose, of severe generalised tuberculosis.

C. Goat. 1412. Parotid, submaxillary and pharyngeal glands extensively diseased. Liver one tubercle. Thoracic glands moderately affected.

C. Goat. 1422. Parotid, submaxillary, pharyngeal and thoracic glands extensively diseased.

Group III. Eleven months after infecting dose of tubercle bacilli.

V. Goat. 1414. Parotid, submaxillary and pharyngeal glands slightly affected.

V. Goat. 1401. Parotid, submaxillary and pharyngeal glands extensively diseased.

V. Goat. 1409. Parotid, submaxillary and pharyngeal glands slightly affected.

V. Goat. 1438. Parotid, submaxillary and pharyngeal glands moderately affected.

V. Goat. 1428. Parotid and phayngeal glands slightly affected.

C. Goat. 1440. Parotid, submaxillary, pharyngeal and thoracic glands extensively diseased.

C. Goat. 1420. Parotid, submaxillary, pharyngeal and thoracic glands extensively diseased. Lungs ten tubercles. Spleen two tubercles.

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C. Goat. 1443. Submaxillary gland slightly affected; pharyngeal gland moderately affected; parotid gland extensively diseased. One tubercle right lung.

C. Goat. 1450. Submaxillary, parotid, pharyngeal and thoracic glands extensively diseased.

Group IV. Twenty months after infecting dose of tubercle bacilli.

V. Goat. 1442. Parotid, submaxillary and pharyngeal glands extensively diseased. Thoracic glands slightly diseased. One tubercle left lung.

V. Goat. 1415. Submaxillary glands slightly diseased; parotid and pharyngeal glands extensively diseased. Thoracic glands slightly affected. Two tubercles left lung and one tubercle right lung.

V. Goat. 1457. Submaxillary and pharyngeal glands slightly affected.

C. Goat. 1437. Submaxillary, parotid and pharyngeal glands moderately affected. One tubercle thoracic glands; one tubercle hepatic gland. Two tubercles right lung and one tubercle left lung.

C. Goat. 1425. Submaxillary, parotid, pharyngeal and thoracic glands extensively diseased. Three tubercles left lung, two tubercles right lung.

V. Goat = vaccinated goat.
C. Goat = control goat.

Tuberculin Tests

Vaccine against Johne's disease is now being used in a small number of "attested" herds in which severe losses from the disease have occurred over a number of years, and where the usual methods of control have failed. In the event of vaccinated animals contracting tuberculosis there is little information available on the comparative tuberculin test reactions that would be induced by the dual infection. It was considered that tuberculin tests of vaccinated goats that had subsequently been infected artificially with bovine tubercle bacilli might provide some answer to this question. Thirteen of the goats used in the cross-protection tests were submitted to comparative tuberculin tests.

Five months after the infective dose of tubercle bacilli the goats were tested on opposite sides of the neck with mammalian and avian P.P.D. Three of these goats and one control were retested in the caudal fold nineteen months after the infective dose of tubercle bacilli (see table).

Eight vaccinated goats, tested five months after infection with tubercle bacilli, gave a larger reaction to mammalian tuberculin than to avian; in four goats the avian reaction was greater and in one goat the two reactions were equal. A retest of three of these goats in the caudal fold nineteen months after infection with tubercle bacilli showed no appreciable difference between the two tuberculins. In animals that have been vaccinated against Johne's disease and that are free from tuberculosis, the avian reaction is usually greater than the

TABLE 2

Goat number	Pre-injection measurements	Avian P.P.D. mm.	Mammalian P.P.D. mm.	Remarks
V. 1438	Pre-injection	16	17	M + 1
V. 1415	skin measure-	27	20	A + 7
V. 1459	ments varied	14	27	M + 13
V. 1409	from 2 mm.	18	20	M + 2
V. 1401	to 4 mm.	25	24	A + 1
V. 1428		13	22	M + 9
V. 1461		26	26	—
V. 1414		15	17	M + 2
V. 1433		18	11	A + 7
V. 1454		13	18	M + 5
V. 1442		14	22	M + 8
V. 1457		17	22	M + 5
V. 1434		20	18	A + 2
	Re-tested in the caudal fold nineteen months after infection with T.B.			
V. 1442		+++	+++	—
V. 1415		+++	+++	—
V. 1457		++++	++++	—
C. 1425		+	++	M +

V = vaccinated. C = unvaccinated control.

mammalian; occasionally the mammalian reaction is the greater, but whether this is a result of vaccination or from a complicating non-specific sensitisation is impossible to determine. As a considerable number of non-specific reactions of unknown origin are encountered in routine tuberculin tests, it is improbable that all of these large mammalian reactions are caused by vaccination.

It would appear from these results that reliance cannot be placed in comparative tuberculin tests for differentiating between tuberculin reactions induced by Johne's vaccine and those arising from a superimposed tuberculous infection.

Conclusions

(1) It would appear from these results that Johne's vaccine afforded an appreciable degree of protection to goats against bovine tubercle bacilli. The tuberculous lesions present in vaccinated goats examined at five, eight and eleven months, respectively, after the infective dose of tubercle bacilli, were considerably less than in controls, but the lesions in vaccinated goats examined twenty months after the infective dose were as extensive as in controls.

(2) When goats vaccinated against Johne's disease were artificially infected with bovine tubercle bacilli, the comparative tuberculin test failed to differentiate between the tuberculin reactions induced by Johne's vaccine and those arising from a superimposed tuberculous infection.

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Acknowledgment

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THE THERAPEUTIC AND PROPHYLACTIC PROPERTIES OF ANTRYCIDE IN TRYPANOSOMIASIS OF CATTLE

A review* of work done under Colonial Development and Welfare Scheme R 318, 1949 to 1952

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PART I

I. Introduction

CURD AND DAVEY (1950) described a trypanocidal drug, antrycide, which was shown to have the following properties in mice:—

(1) It was active against more species of trypanosomes than were other trypanocides;

(2) The therapeutic index was wider; and

(3) An insoluble salt, the dichloride, administered subcutaneously in emulsion protected mice for an unusually long period.

As a result of arrangements between Imperial Chemical (Pharmaceuticals) Ltd., the Colonial Office and Sudan Government, field trials were undertaken in the Sudan, Uganda and Kenya, based on Khartoum, Entebbe and Kabete. Imperial Chemical (Pharmaceuticals) sent Dr. D. G. Davey to Africa with experienced laboratory technicians. At each centre selected, Davey was assisted by the provision of laboratory accommodation and by local research staff. The cost of the experiments in Kenya, with the exception of that of I.C.(P.) staff, was borne by the East Africa High Commission. The results were reported by Davey (1950).

* This review is an abbreviated version, brought up to date, of a report to the Secretary of State for the Colonies. The original report contains 42 pages of typescript and LXIX appendices. Protocols, containing virtually all the data collected, are included. Copies have been lodged with the Secretary of the Tsetse and Trypanosomiasis Committee at the Colonial Office in London and with the Director, E.A.T.T.R.R.O., Nairobi, Kenya.

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Exaggerated implications had, prior to Davey's publication, been attached by the lay Press to a preliminary announcement made by the Colonial Office; from this hopes had arisen that cattle might forthwith be raised in tsetse areas and a world meat shortage alleviated. It was always considered in responsible quarters that more extensive tests would be necessary, especially in relation to the prophylactic properties of the drug.

In order that such tests might be started without delay, special financial aid was sought from Colonial Development and Welfare funds for a programme, which was to extend over three years. The suggested programme and estimates were accepted by the Colonial Office, and Treasury sanction for the expenditure was received early in 1949. A total sum of £15,800 was granted.

First period—March, 1949, to March, 1950.—Davey's cattle were maintained at his original field station at Kiboko, an area heavily infested with *Glossina pallidipes*, *G. longipennis*, and *G. brevipalpis*. This work was supervised during the writer's absence in the United Kingdom from March to September, 1949, by Mr. H. R. Binns. Observations provided information about the pathology of suppressed types of trypanosomiasis and about the dangers of disseminating drug-fast trypanosomes.

Second period—March, 1950, to March, 1951.—In March, 1950, following the appointment of Mr. J. Macdonald, M.R.C.V.S., as research officer, a new field station was opened at Mariakani in an isolated area of woodland infested with *G. austeni*. The aim was to test the prophylactic properties of antrycide administered at fixed intervals to cattle in tsetse fly country. Cows in calf were introduced so as to observe the effect of contact with tsetse flies on pregnancy and parturition, and on young animals reared from birth in contact with tsetse flies. At Kabete work was done in an attempt to gain clues about the nature of the prophylaxis afforded by antrycide. Work was also done at Kabete on treatment of cattle infected with *Trypanosoma congolense* and *T. vivax*.

Third period—March, 1951, to March, 1952.—Additional experiments were introduced at Mariakani both on treatment and prophylaxis in an attempt to assess the value of antrycide sulphate in field treatment and to discover the limitations of the chloride as a prophylactic. At Kabete, work on drug fastness was continued.

II. The Problems Studied

Treatment

Davey (1950) described satisfactory results in the early treatment of infections due to *T. congolense* and *T. vivax*. Further information was required about treatment of late cases of acute trypanosomiasis and of chronic stages of the disease.

Prophylaxis

In the laboratory, Davey had demonstrated that injections of antrycide chloride were effective in preventing the appearance of *T. vivax* in the peripheral

blood of cattle provided that the challenge was made within three to four months, and of *T. congolense* provided that the challenge was made within five to six months. He started experiments at Nsongezi, in Uganda, and at Kiboko, in Kenya, to test whether similar results would be obtained in tsetse areas. Results appeared to confirm those of the laboratory tests, positive blood slides being only found after similar periods. Some cattle, however, died at Kiboko and in spite of negative blood smears a diagnosis of trypanosomiasis was made by the writer (as recorded by Davey, 1950). In addition to the evidence of the autopsy, cattle were examined which appeared clinically to be infected with trypanosomiasis.

At the time of Davey's departure, smears of gland juice were examined from all his cattle at Kiboko and, in spite of the negative blood smears, 18 of 56 were found infected with *T. congolense* or *T. vivax*. In addition, certain serological tests had given positive results and this was considered to be evidence of cryptic infection (Fiennes, 1950). Further evidence of cryptic infection was obtained from three cattle, brought to Kabete from Kiboko. In all three cases, trypanosomes were found in blood smears after prolonged negative periods, confirming a diagnosis of infection made on clinical grounds. The histories of these cattle will be given later.

From the days of Ehrlich onwards, there has been considerable conjecture as to whether drugs are directly trypanocidal or whether they act in conjunction with the natural or acquired defences of the body. It is well known, for instance, that drugs, including antrycide, are ineffective in destroying trypanosomes *in vitro* in concentrations effective in the living body; furthermore, often parasites are not removed from the blood for some days, possibly due to the time taken for the defences of the body to be mobilised. Kligler and Weitzmann (1926) injected *T. evansi* suspended in Bayer 205 solution into guinea-pigs and found that, although infection was not established, antibody production was stimulated, in some cases to the extent of creating immunity.

There was, therefore, reason to suppose from the theoretical aspect that drugs might not act as prophylactics in the sense that they would prevent a temporary lodgement of parasites in the body. From the practical aspect, there was reason to believe that, in spite of the absence of parasites from the circulating blood, Davey's cattle had been infected with trypanosomiasis and that some had died of it. There was nothing revolutionary in this idea, since it is now accepted that the cryptic form of infection, represented by premunity, may be accompanied by symptoms of ill-health; the literature on this subject was reviewed by Fiennes (1950).

It was thus important to establish whether repeated injections of antrycide could confer a durable and sterile immunity or whether under its influence a cryptic infection, with accompanying premunity, would be established. There was no time in which to develop a reliable serological test, so that experimental cattle required to be studied for signs of sub-clinical disease, and attempts were made to demonstrate parasites, by means of blood sub-inoculation, examination of tissue smears, and provocation by shock and intercurrent infection.

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III. Experiments at Kiboko

Davey (1950) has described the initial stages of the work at this site. His original object had been to determine the interval between exposure of cattle, treated with various mixtures of the two salts of antrycide, and the appearance of trypanosomes in blood smears. In this work, *T. vivax* infections were ignored and the cattle were only re-treated when infection with *T. congolense* was diagnosed. It proved impossible, thereafter, to eliminate infection by drug therapy and the cattle, of which only a small proportion survived, continued to suffer from chronic trypanosomiasis in spite of treatment. Parasites were present in blood smears only intermittently and often in small numbers; nevertheless, there was severe anæmia as shown by hæmoglobin figures (by the Tallquist method) of 50 per cent or under. The histories of these cattle and of

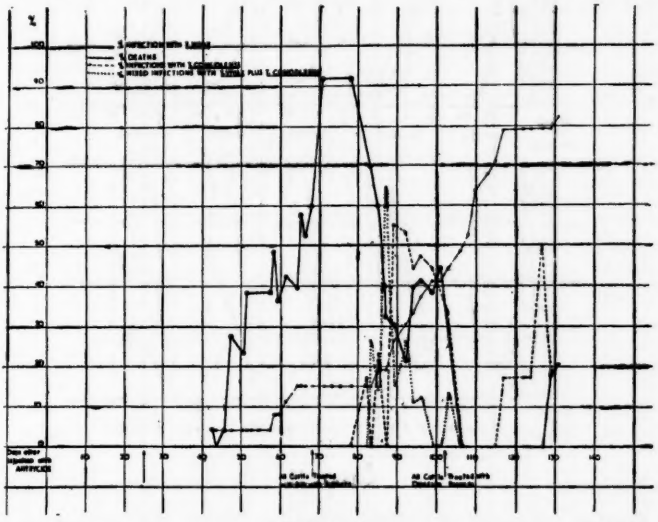

CHART I

dimidium-protected cattle are to be given by Fiennes (1952, *a*, *b*). The surviving cattle were eventually killed for autopsy 18 to 24 months after their original exposure to tsetse flies. An account of the autopsies, together with those of some dimidium-protected and untreated control cattle, are to be given by Fiennes (1952, *b*).

IV. Cryptic Infection

(1) It was possible to demonstrate a myocarditis in the cattle killed for autopsy at Kiboko, associated with the presence of trypanosomes in the cardiac capillaries. Fiennes (1952, *a*), describing these results, expressed the view that symptoms were more probably due to the presence of trypanosomes in this site than to a desultory infection of the peripheral blood. He therefore considered that there existed a form of trypanosomiasis not necessarily dependent on blood infection.

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(2) In the course of experiments at Kabete during the past three years, only one ox has survived infection with *T. congolense* to the point of an apparent natural recovery. Sub-inoculations of blood from this animal reproduced infection 16 days after the absence of trypanosomes from blood and gland smears. It was killed 9 weeks after blood smears had become negative, and large numbers of trypanosomes, mostly in a state of lysis, were found in smears from the kidney and heart.

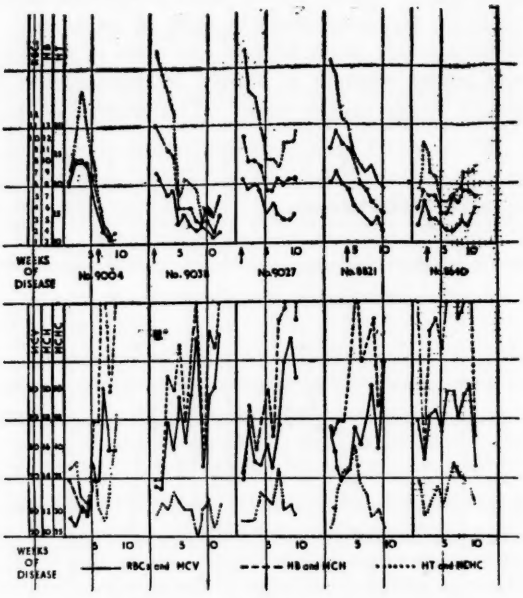

CHART II

(3) Further evidence of cryptic infection during the natural course of the disease came from a goat, which was exposed to tsetse flies at Mariakani. This animal died without showing positive blood smears but trypanosomes, also mostly in a state of lysis, were found to be numerous in lung smears. Roubaud (1951) has also described the death of a goat from cryptic *T. congolense* infection.

(4) Evidence of cryptic infections following the use of antrycide as a prophylactic will be found in the section devoted to work on anæmia.

There is, therefore, evidence that a cryptic stage may occur with infections of *T. congolense* and *T. vivax*; that this stage may be accompanied by pathological symptoms; and that there is a tendency for its development, where drugs are used prophylactically.

V. Drug Fastness Experiments with Antrycide and Dimidium

In continuance of Davey's work at Kiboko, two groups of cattle were treated with antrycide dichloride and sent to Kiboko, 25 and 21 days respec-

tively after treatment. The first group consisted of 27 cattle plus 3 untreated controls. The second group consisted of 30 cattle and no controls.

Cattle in both groups quickly succumbed to infection with *T. vivax* and *T. congolense*. Survival time was longer than that of the controls, but incubation period similar.

Treatment with antrycide sulphate did not affect the numbers of cattle showing positive blood smears for *T. vivax*. When treated subsequently with

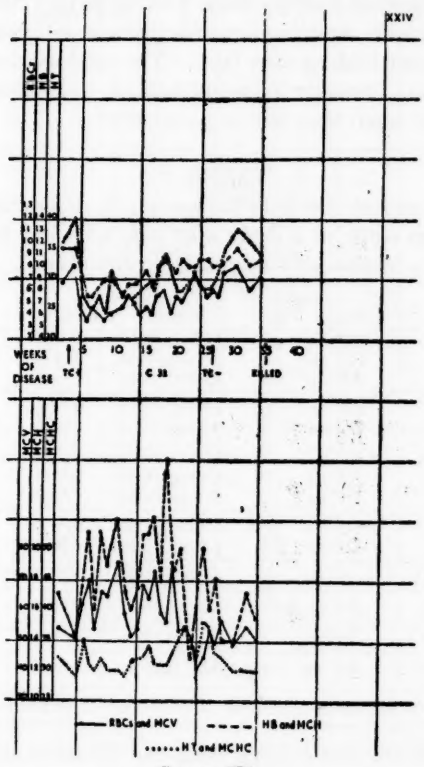

CHART III

dimidium bromide, trypanosomes were removed from the circulating blood but deaths were not arrested. Results with one group are shown graphically in Chart I.

Following this failure, steps were taken to test the infecting trypanosomes for drug fastness.

EXPERIMENTS WITH *T. vivax*

Pooled blood from 5 cattle at Kiboko, Nos. 031 to 035, was injected into 2 cattle at Kabete, Nos. 8964 and 8771. Both the sub-inoculated cattle became infected with *T. vivax*. The 5 original cattle were brought to Kabete, where all showed *T. vivax* in blood smears. Four more cattle, Nos. 8757, 9763, 8795

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and 8841, were sub-inoculated with pooled blood from Nos. 031 to 035 and became infected with *T. vivax*.

Nos. 031 to 035 were treated with antrycide sulphate. There was no effect on the numbers of trypanosomes found in blood smears.

The 6 sub-inoculated cattle were treated with antrycide sulphate, 2 at 2.0 mg./kilo, 2 at 3.0 mg./kilo and 2 at 5.0 mg./kilo. One of the latter died 5 days later; with this exception, all the cattle again showed trypanosomes in blood smears after intervals varying from 9 to 14 days. Nos. 031 to 035 were then given treatment with dimidium bromide; blood and gland smears remained negative until they were sold 14 days later. The sub-inoculated cattle were also treated with dimidium bromide following relapse, and blood smears remained negative for 17 days, when they likewise were sold.

TABLE 1

Showing the results of tests for drug-fastness on T. congolense *which had been collected in rats from cattle at Kiboko after infection had broken through protection with antrycide or dimidium.*

	Strain of tryp.	Source	No. of rats	Antrycide Dosage	Antrycide Results	Dimidium Dosage	Dimidium Results
Test I:	Series II	AP ox	8	1.0 mg./kilo	4/4 R	1.0 mg./kilo	0/4 R
	Series II	AP ox	8	1.5 mg./kilo	4/4 R	1.5 mg./kilo	0/4 R
	Series II	AP ox	8	2.0 mg./kilo	4/4 R	2.0 mg./kilo	0/4 R
Test II:	Series III	DP ox	8	1.0 mg./kilo	0/4 R	1.0 mg./kilo	4/4 R
	Series III	DP ox	8	1.5 mg./kilo	0/4 R	1.5 mg./kilo	4/4 R
	Series III	DP ox	8	2.0 mg./kilo	0/4 R	2.0 mg./kilo	4/4 R
Test III:	Series II	AP ox	8	4.0 mg./kilo	3/4 R	2.0 mg./kilo	4/4 R
	Series III	DP ox	8	4.0 mg./kilo	0/4 R	2.0 mg./kilo	4/4 R
Test IV:	Series II	AP ox	5	5.0 mg./kilo	5/5 R		
	Series III	DP ox	4	5.0 mg./kilo	4/4 R		
Test V:	Series XIV	AP ox	8	4.0 mg./kilo	4/4 R	2.0 mg./kilo	4/4 R
Test VI:	Series XV	AP ox	8	4.0 mg./kilo	4/4 R	2.0 mg./kilo	4/4 R
Test VII:	Series XVI	AP ox	7	4.0 mg./kilo	3/3 R	2.0 mg./kilo	4/4 R
Test VIII:	Series XVII	AP ox	8	4.0 mg./kilo	4/4 R	2.0 mg./kilo	4/4 R

A = antrycide AP = antrycide protected DP = dimidium protected R = relapsed

On the basis of Davey's original tests, the *T. vivax* strain from Nos. 031 to 035 did not respond normally to antrycide therapy either in the original hosts or in fresh cattle. The response to dimidium was normal, but the cattle were not retained sufficiently long to observe their further history.

EXPERIMENTS WITH *T. congolense*

Six strains of *T. congolense* were collected, in rats, from cattle at Kiboko. One was taken from a dimidium-protected ox and 5 from antrycide-protected oxen. Tests were made in rats to discover the response to antrycide and dimidium.

Strain II from an antrycide-protected ox was not cured by antrycide at the dosage used, but was in one of two tests cured by dimidium. Strain III from a dimidium-protected ox was not cured by dimidium, but was cured in

two of three tests by antrycide. All the other strains proved to be fast to both antrycide and dimidium. Results are given in Table 1.

These tests show that strains of *T. congolense*, isolated from cattle which had become infected following protection with antrycide or dimidium under natural conditions, were resistant to one or both drugs.

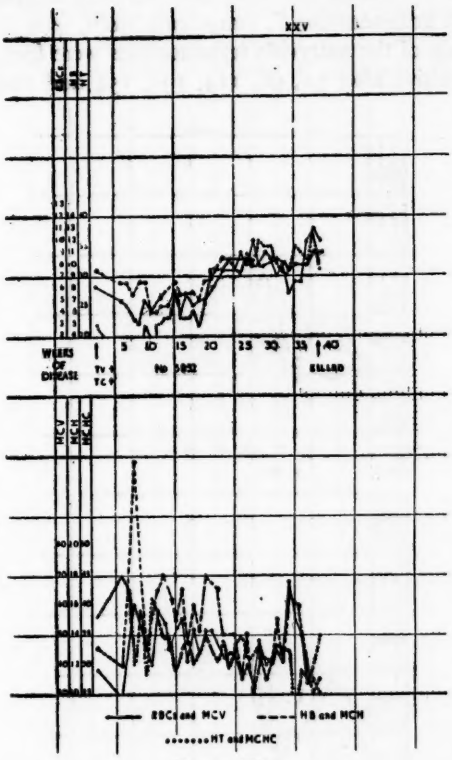

CHART IV

VI. General Experiments with Drug Fastness

(1) TRYPANOSOMES COLLECTED AT KIBOKO FOLLOWING REMOVAL OF DRUG-TREATED CATTLE

Following the removal of drug-treated cattle from Kiboko, untreated control cattle were sent there for collection of trypanosome strains for tests of fastness. One strain of *T. vivax* was resistant to antrycide after 5 months and one of two strains of *T. congolense* after 7 months.

Collection of *T. congolense* proved difficult, because *T. vivax* usually proved fatal before this was transmitted.

(2) ATTEMPTS TO CREATE DRUG FASTNESS TO ANTRYCIDE IN MICE

An attempt was made to create a strain of *T. congolense* fast to antrycide by sub-curative dosage of mice and passage. In common with other workers

(*vide* Calver, 1945), little success was attained. The attempt was eventually abandoned owing to shortage of mice.

(3) ATTEMPTS TO CREATE DRUG FASTNESS TO ANTRYCIDE IN CATTLE

(*a*) Six cattle were given, at different times, protective injections of antrycide pro-salt. At weekly intervals, they received injections of blood from cattle infected with drug-sensitive *T. congolense,* until, with the disappearance of the protective action of the antrycide trypanosomes were found in blood smears. Smears became positive after 91, 98, 114, 133, 154 and 162 days respectively.

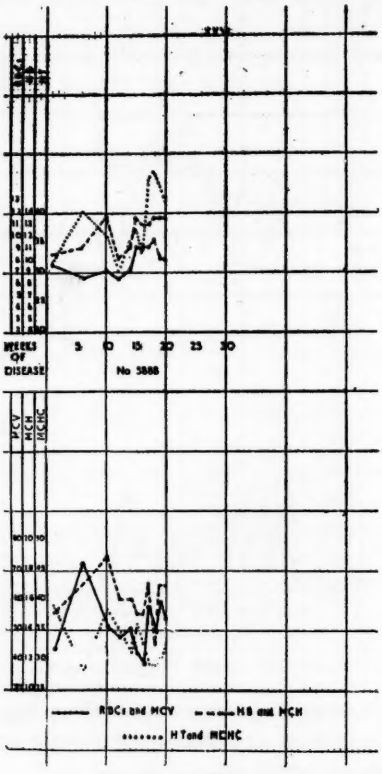

CHART V

In 4 cases of 6, the recovery strain of *T. congolense* failed to respond to antrycide therapy in mice.

(*b*) Antrycide-fast trypanosomes from 2 of these cases were used to challenge 2 further protected cattle. These 2 cattle became infected with *T. congolense* after 1 and 2 weekly challenges respectively, showing that pro-salt was unable to protect from infection with antrycide-fast *T. congolense.*

(*c*) Trypanosomes were sub-inoculated from 1 of the cattle mentioned in (*b*) above into a further ox. Blood of this ox was used to challenge 2 further oxen,

which had received injections of pro-salt. These 2 oxen resisted infection. The parasites, tested in mice, were now found to be antrycide-sensitive.

(*d*) One of the cattle, in which drug-fast *T. congolense* had appeared, was given doses of antrycide sulphate (1.0 mg./kilo), in an attempt to enhance drug resistance. Relapses occurred after 21, 11, 17 and 35 days respectively. Thereafter, trypanosomes disappeared from blood smears. One month after the last relapse and treatment, the animal was provoked by an injection of TAB vaccine (5 c.c. sc.), followed by twice daily injections of adrenalin (6 c.c. of 1 : 1,000)

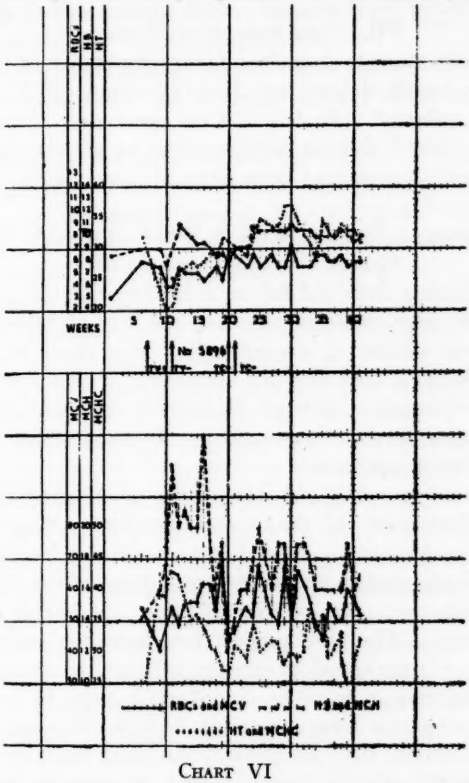

CHART VI

for 3 days. *T. congolense* appeared very scantily in the blood, for 1 day only, 3 days later. This ox has now been negative for 5 months and is regarded as cured.

The importance of this work is threefold. Firstly, though numerous workers have succeeded in creating drug-fast strains of the polymorphic trypanosomes, no success has attended efforts to create drug-fast *T. congolense;* the literature has been reviewed by Calver (1945). *T. congolense* has now been rendered drug-fast under approximately field conditions, suggesting that fastness at Kiboko was the result of a created drug-fastness and not of selection of naturally-resistant parasites, which would plainly be the first to infect the treated cattle.

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In the second place, the loss of drug-fastness is alien to results obtained with polymorphic trypanosomes. The literature cannot be reviewed here, but reference may be made to Dobell (1912), who reviewed work done up to that date, and concluded that fastness could be lost if trypanosomes were transferred to different species of host. The third point of importance lies in the cure of an ox infected with an antrycide-fast *T. congolense* by repeated *small* injections of antrycide sulphate. The work, in general, suggests that the problem of drug-fastness may be of less importance with *T. congolense* than has hitherto been supposed.

VII. Drug-fastness at Mariakani

It is well at this stage to state that during the course of the experiments at Mariakani, to be described later, no drug-fast strains of *T. congolense* or *T. vivax* have been collected. At this station, great care was taken to remove any treated cattle, which showed positive blood or gland smears, from contact with tsetse flies until smears had been negative for at least three weeks.

VIII. Experiments to Test the Ways in Which Antrycide Gives Protection Against Trypanosomiasis in Mice

In the experiments described below, antrycide chloride was used to protect mice and attempts were made to ascertain the fate of injected trypanosomes. Owing to divergent results, a re-examination was made of the prophylactic properties of the various salts and salt mixtures. It was found from this that, whereas antrycide pro-salt, a mixture of sulphate and chloride, gave uniformly good results, no other preparation or mixture of preparations was reliable. The following preparations were tested:—

(1) pro-salt; (2) antrycide chloride alone, as supplied by manufacturers; (3) antrycide sulphate alone; (4) the super-natant from a suspension of antrycide chloride; (5) antrycide chloride filtered from a solution/suspension of pro-salt; (6) antrycide sulphate, plus kaolin in the proportions of the chloride in pro-salt.

Different results were obtained in different experiments and protocols are not, therefore, given. The only preparation, however, which always gave a sterile prophylaxis was the chloride/sulphate mixture, as represented by pro-salt.

In the experiments, now to be described, it must be concluded that the full properties of antrycide were not tested, but that low-grade infections were created. For this reason, they are possibly the more valuable as throwing light on what happens to antrycide-treated cattle exposed to tsetse flies, since it appears that a similar low-grade infection occurs under these conditions.

Experiment 1. Fifteen mice received antrycide chloride at a dosage level of 0.4 mg./kilo, much below what would be expected to give more than slight protection. They were challenged on the 6th, 8th and 10th days with *T. congolense* in mouse blood. They were killed 14 days after the challenge, blood smears still being negative. Examination of heart smears revealed the following: Negative 6; *T. congolense* scanty 4; *T. congolense* numerous 5. In sections, severe cardiac lesions were found in 9 of the hearts associated with the presence of trypanosomes.

The localisation of parasites in the hearts is of interest in relation to the same occurrence in cattle, which received inadequate dosage with antrycide at Kiboko.

Experiment 2. An attempt was made to ascertain the fate of *T. congolense* injected intraperitoneally into normal mice and mice protected with antrycide chloride at a dosage of 4.0 mg./kilo. One week after injection with antrycide, the mice were challenged with intraperitoneal injections of mouse blood containing *T. congolense.* An equal number of unprotected control mice was injected at the same time. One control and one treated mouse were killed at hourly intervals up to the seventh hour. Smears from blood, peritoneal fluid and tissues were examined. Results showed that:—

(1) In both the normal and protected mice, the majority of the injected trypanosomes were destroyed, but a small number survived as a focus of infection;

(2) In both groups, a few parasites could always be found in the peritoneal cavity or in tissue smears, especially those of lung, liver and kidney;

(3) There was no difference between the control and treated mice.

Experiment 3. Experiment 2 was repeated but the dose of antrycide was 12.0 mg./kilo. Similar results were obtained.

These experiments showed that:—

(1) Only a small proportion of *T. congolense* introduced by needle into the peritoneal cavity of normal mice is able to survive.

(2) No differences are encountered in this respect between mice that have received large doses of antrycide and those that have not.

Experiment 4. Mice were injected with antrycide chloride at 4.0 mg./kilo. They were challenged with *T. congolense* in mouse blood on the 7th, 9th and 11th days. Control mice were injected at the same time. Two control and 2 protected mice were killed on the 1st to 13th days after challenge. Blood peritoneal fluid and tissues were examined by smear examination.

Results showed that in the majority of cases, trypanosomes could be detected in tissue smears before they appeared in blood smears. The control mice had all shown a heavy infection by the 7th day and examination was discontinued. In the protected mice, *T. congolense* were found in the tissue smears on the 4th to 12th days but not on the 13th. On the 10th day, 2 mice showed scanty trypanosomes in the blood, on the 12th, 1 mouse showed numerous trypanosomes.

Experiment 5. Experiment 4 was repeated but a dose of 12.0 mg./kilo of antrycide was used. The control mice behaved as in the previous experiment. In the experimental mice, trypanosomes were found in the tissues on the 1st, 7th and 13th days after injection. They were not found on the 2nd, 3rd, 4th, 5th, 6th, 8th, 11th, 12th, 14th or 15th days. No mice were examined on the 9th or 10th days. On the 13th day 1 mouse showed very scanty parasites in the blood.

Results suggest that in the protected mice there was a residual focus of parasites, which made abortive attempts to invade the general circulation. These attempts appear to have been made at intervals corresponding to a normal incubation period.

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Experiment 6. Mice protected with antrycide at 12.0 mg./kilo were challenged 7, 9 and 11 days afterwards. Two mice were killed on the 5th, 6th, 7th, 8th, 11th, 12th, 13th, 14th and 15th days after the challenge. Four antrycide-treated mice were retained as controls, 2 of which developed infections with *T. congolense* on the 35th and 41st days respectively; the other 2 remained healthy. Blood from the killed mice was pooled and injected intraperitoneally into 3 healthy mice.

T. congolense was transmitted by the blood of the treated mice on the 5th

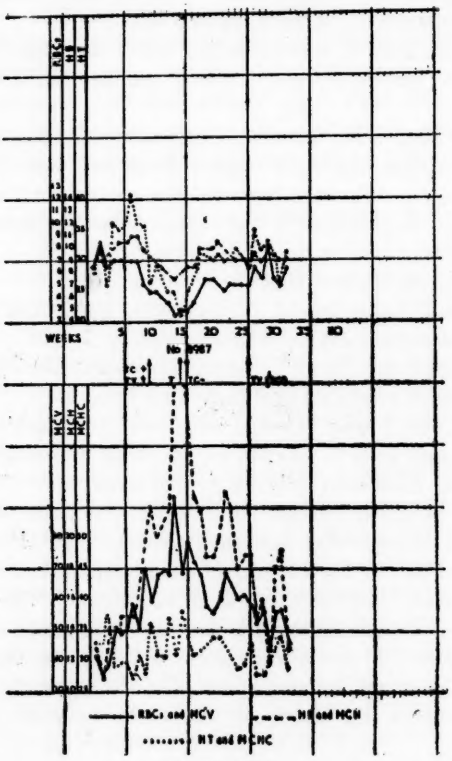

CHART VII

to 8th days after challenge, and on the 12th and 13th days; it was not transmitted on the 11th, 14th and 15th days.

These results support the suggestion of periodical invasion attempts given by Experiment 5.

XI. The Anæmia of Trypanosomiasis

It was, for reasons already discussed, important that cattle under experiment should be examined for disease signs which might indicate cryptic infection. The anæmia was suitable for study, since it could be readily measured by recognised methods. Attempts were, therefore, made to obtain further inform-

ation about these anæmias. It must here be added that subsequent work has revealed a number of new facts about these anæmias; certain material is being prepared for publication but is not included here.

The anæmia in the acute stage. The blood changes, which occurred in 5 cattle in the acute stages of *T. congolense* infection, are shown in Chart II. There was a concurrent fall of the red cell, hæmoglobin and hæmatocrit estimations until the crisis was reached. At this stage, 2 of the cattle died, in the remaining 3 there was a slight improvement, death taking place after the crisis.

The lower curve, which gives mean corpuscular volume, mean corpuscular hæmoglobin and mean corpuscular hæmoglobin concentration, shows that as the anæmia progressed the red cell size, the quantity of hæmoglobin in each red cell, and in some cases the percentages of hæmoglobin, were increased.

TABLE 2

Showing the history of Ox No. 5888, which was cryptically infected with trypanosomiasis.

7/10/48.	Received 1.5 g. of antrycide sulphate plus 1.0 g. of antrycide chloride;
19/10/48.	Sent to Kiboko, where blood smears remained negative throughout;
31/ 3/49.	Brought to Kabete, away from contact with tsetse flies;
30/ 9/49.	Clinically examined by the writer on his return from U.K., and judged to be infected with trypanosomiasis;
22/12/49.	Blood smears had remained negative in spite of daily examination; on this date, 1 trypanosome, probably *T. congolense*, was seen by the writer in a thin smear; the trypanosome was in a state of partial lysis and half ingested by a monocyte;
25/ 5/50.	Killed; sections of the heart showed traces of trypanosomes in capillaries.

Initially, the red cells were morphologically normal; but as the crisis approached there was anisocytosis due to the presence of macrocytes, polychromasia, punctate basophilia and hypochromia. The anæmia at this stage was similar to that encountered in cattle acutely infected with parasites of the blood such as Babesia or Anaplasma.

The anæmia of the chronic stage. Charts III and IV show the changes of the blood picture in 2 cattle during the chronic stages of infection with *T. congolense*. The outstanding feature at this stage is the tendency of the red cell count to recover—at times to very high levels. This is often accompanied by low hæmoglobin and hæmatocrit figures, with consequent low MCV and MCH. Macrocytes disappear and the red cells are morphologically normal. There is, however, considerable anisocytosis, but this is due to the presence of large numbers of microcytes. High red cell count plus high hæmatocrit is

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physiological, but high red cell count with low hæmatocrit is a feature of the chronic stages of *T. congolense* infection.

The anæmia of the cryptic stage. The blood picture was studied in 2 cattle Charts V and VI, which were cryptically infected with *T. congolense* or *T. vivax*. Their histories are given in Tables 2 and 3. The same contrary tendencies of the red cell and hæmatocrit curves are seen as in the chronic stages. This is to say that there is a periodical flushing of the vascular system with very small cells, which carry little hæmoglobin.

The anæmia during the recovery phase following treatment. Charts VII and VIII show the changes of the blood picture, which occurred in 2 of 4 cattle, which were infected with *T. congolense* and *T. vivax* and treated with antrycide sulphate after the red cell counts had fallen to below 3 million per c.mm. In all 4 cattle, there was recovery of the blood picture to figures approaching normal, but secondarily changes occurred similar to those of cattle suffering from chronic or cryptic trypanosomiasis; this is to say that the red cells rose to high figures but the hæmatocrit and hæmoglobin figures were reduced.

In 2 of the 4 cattle (*vide* charts), these secondary changes were associated with the reappearance of *T. vivax* in very small numbers. This reinforces the belief that high red cell and low hæmatocrit figures may be associated with low-grade trypanosome infections.

The blood picture in normal control cattle. The blood picture in a number of normal control cattle has been studied. These studies will be the subject of

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TABLE 3

Showing the history of Ox No. 5896, which was cryptically infected with trypanosomiasis.

7/10/48.	Received 1.5 g. of antrycide sulphate plus 1.0 g. of antrycide chloride;
19/10/48.	Sent to Kiboko, where it never showed positive blood smears;
31/ 3/49.	Brought to Kabete;
10/ 5/49.	*T. congolense* appeared in blood smears and was present continuously until 21/9/49; blood smears continued to be examined daily and gave the results under;
21/12/49.	*T. vivax* 2/600 fields of a thick smear (gland);
23/12/49.	*T. vivax* 1/600 (blood);
28/12/49.	*T. vivax* 5/100 (gland);
5/ 1/50.	*T. vivax* 3/20 (gland);
1/ 2/50.	*T. vivax* 1/600 (gland);
3/ 2/50.	*T. vivax* 1/600 (blood);
5/ 4/50.	*T. congolense* 2/600 (gland);
6/ 4/50.	*T. congolense* 1/600 (blood);
12/ 4/50.	*T. congolense* 1/600 (gland);
11/ 6/51.	Killed; tissue smears showed no signs of trypanosomes; sections also negative.

publications elsewhere. It must here be stated that the characteristic feature of chronic and cryptic trypanosomiasis, the red cell rise and hæmatocrit fall, may very occasionally be encountered in apparently normal cattle. This is probably due to temporary activity of Anaplasms or Piroplasms from premunition foci. These changes are, therefore, not diagnostic of trypanosomiasis, though where the history indicates the possibility of infection they are a useful guide to diagnosis.

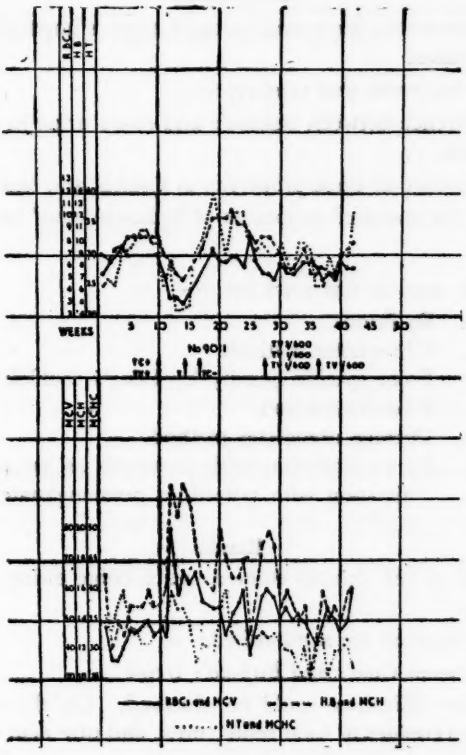

CHART VIII

The blood picture in normal cattle, which received monthly injections of antrycide. Three cattle were given injections of antrycide chloride/sulphate mixture and blood examinations were made weekly as in the case of other cattle studied. It was ascertained from this that the monthly administration of the antrycide mixture had no effect on the normal blood picture.

[END OF PART I]

XUM

A STUDY OF BOVINE URINE IN HEALTH AND DISEASE

By Prof. M. R. SHOURBAGY, Ph.D., and
ABDEL MONEM AHMED, B.Sc.
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Introduction

It is well known that the examination of urine is important in the diagnosis of some cattle diseases.

The aim of this work was to study:—

(1) The difference between buffalo's and cow's urine in some physical and chemical properties;

(2) The difference in these properties in normal and sick animals;

(3) Some of the chemical properties of Sudanese cows' urine.

Procedure

The methods used in this work are:—

Reaction	By litmus.
Specific gravity ..	Urinometer method.
Total solids	From specific gravity by Long's coefficient method.
Albumin	Esbach's method.
Urea	Dormus ureometer method.
Uric acid	By precipitation with ammonia as ammonium ureate and titration with potassium permanganate.

Results

The urine of all the animals studied was alkaline owing to the presence of earthy phosphate.

The results obtained are summarised:—

(1) *Difference between Cow's and Buffalo's Urine*

No qualitative difference could be observed. On the other hand, it was found that the percentages of total solids, urea, and uric acid were higher in the buffalo's than in the cow's urine.

Albumin could not be detected in the buffalo's urine even in the sick and aged animals while it could be found in the case of sick cow's urine. This is recorded in Tables 1 and 2.

(2) *Difference between the Urine of Sick and Normal Animals*

(*a*) Sugar could not be detected in any of the observed samples.

(*b*) An increase was found in the percentages of urea, total solids and specific gravity in sick working cows' urine, but after recovery the percentage of urea, total solids and specific gravity came down to its normal level. This may be due to the difference in protein intake and metabolism between the healthy and sick animals.

(*c*) Albumin could be observed in the case of aged and sick cows. It was also found in the urine of cows after giving birth.

(*d*) Stones consisting of calcium carbonate, oxalate and phosphate could be seen in the bladders of some cows.

Tables 3 and 4 show the analysis of some sick cows' and buffaloes' urine.

(3) *Analysis of Sudanese Cows' Urine*

There was no difference between the samples obtained from Sudanese cows and those of the Egyptian cows. Albumin was also present in the urine of some Sudanese sick cows. These results are shown in Table 5.

TABLE 1

Analysis of Some Healthy Cows' Urine

Specific gravity	Total solids %	Reaction %	Albumin %	Sugar %	Urea %	Uric acid %
1026	5.80	Strong alkaline	Absent	Absent	1.3	0.063
1025	5.19	" "	"	"	1.0	0.068
1020	5.20	" "	"	"	1.0	0.078
1025	5.70	" "	"	"	1.1	0.081
1024	5.14	" "	"	"	1.1	0.068
1026	5.85	" "	"	"	1.2	0.078

TABLE 2

Analysis of Some Healthy Buffaloes' Urine

Specific gravity	Total solids %	Reaction %	Albumin %	Sugar %	Urea %	Uric acid %
1028	6.07	Strong alkaline	Absent	Absent	1.2	0.142
1036	7.20	" "	"	"	1.4	0.153
1025	6.15	" "	"	"	1.1	0.108
1024	6.20	" "	"	"	1.2	0.115
1034	7.25	" "	"	"	1.8	0.153
1010	5.45	" "	"	"	1.7	0.115

TABLE 3

Analysis of Some Sick Cows' Urine

Specific gravity	Total solids %	Reaction %	Albumin %	Sugar %	Urea %	Uric acid %
1030	6.5	Strong alkaline	Absent	Absent	3.0	0.153
1022	6.6	" "	"	"	4.7	0.63
1026	4.37	" "	Traces	"	4.6	0.079
1025	6.53	" "	0.05	"	3.0	0.115
1020	5.25	" "	0.10	"	1.2	0.153
1018	4.43	" "	0.05	"	1.8	0.133
1027	6.91	" "	0.10	"	2.2	0.153

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TABLE 4

Analysis of Some Sick Buffaloes' Urine

Specific gravity	Total solids %	Reaction %	Albumin %	Sugar %	Urea %	Uric acid %
1037	7.05	Strong alkaline	Absent	Absent	2.4	0.153
1029	6.86	„ „	„	„	2.2	0.133
1030	6.99	„ „	„	„	2.0	0.228
1035	7.12	„ „	„	„	2.1	0.115

TABLE 5

Analysis of Some Sudanese Cows' Urine

Specific gravity	Total solids %	Reaction %	Albumin %	Sugar %	Urea %	Uric acid %
1012	4.64	Strong alkaline	Absent	Absent	2.0	0.148
1012	4.24	„ „	0.15	„	2.2	0.148
1018	5.20	„ „	0.15	„	1.0	0.096
1019	5.19	„ „	0.10	„	1.2	0.115
1017	4.33	„ „	0.25	„	0.3	0.048
1016	4.95	„ „	0.15	„	0.8	0.960

CANINE COCCIDIOSIS

By K. CUMMINGS SUMNER, M.R.C.V.S.

Bristol.

Introduction

AMONG dog owners there is one fetish which is of grave danger to the health of the animal, namely, that the majority of these people consider that all the ailments of their pets are due to endo-parasites, and appear to be aware of only two types, Round-worms and Tape-worms. Worm medicines are administered freely and in most cases quite unnecessarily, and animals are often wormed when no parasites are present with the consequent onset of various forms of enteritis associated with diarrhœa.

Unfortunately, macroscopic endo-parasites do not end the possibility of parasitism, and many cases of chronic ill-health and diarrhœa can be traced to the presence in the intestines of protozoan parasites in the form of Coccidia.

These organisms are not influenced by the normal worm doses and require more specific treatment. There is some difficulty in making the average dog owner understand that a parasite can exist which is so small that a microscope is required to detect its presence.

In view of the apparent increase in the occurrence of this condition, if not throughout the whole country, certainly in this area, it is proposed to set out a few details concerning the organism and to review briefly the life cycle, etc., of the parasite concerned.

Species of Coccidia Involved

Apparently the species of Coccidia affecting the dog are mainly Isospora, namely, *I. rivolta* and *I. bigemina,* but Hagan, 1944, states that one species of Eimeria, namely, *E. canis* is encountered. However, it would appear that the symptoms associated with Coccidiosis in the dog are the same no matter which organism causes the condition and therefore from the viewpoint of the clinician the details of the types, etc., of the organism are of relatively small importance.

Life Cycle

In order to appreciate fully the effect of the presence of Coccidia in the animal body it is necessary to bear in mind the life cycle of the parasite.

The animal becomes infected by ingestion of infected material, i.e., material contaminated by the fæces of the infected animal and therefore carrying oöcysts. These oöcysts each contain sporocysts and each of the latter contains sporozoites. In the case of Eimeria species there are four sporocysts per oöcyst each containing two sporozoites, while in the isospora there are two sporocysts each with four sporozoites.

Following ingestion the sporozoites are liberated and each enters a cell of the intestinal mucosa; here it multiplies and becomes 16 merozoites which are in turn liberated into the lumen of the tube and from there enter other cells of the mucosa and multiply.

A sexual cycle also exists and in this the merozoites develop in the cells into male elements known as microgametes or female elements known as macrogametes. After liberation the two types unite with one another and ultimately become an oöcyst which is passed out in the fæces of the infected creature, to infect another animal. (Cameron, 1934.)

From the foregoing description it will be appreciated that cells of the epithelial lining of the intestine are invaded and destroyed with consequent irritation and inflammation.

Symptoms

Due to the invasion and subsequent bursting of the cells of the intestinal lining an inflammation is set up and there is diarrhœa. Usually the excreta is of a yellow colour in the early stages although normal colour may be maintained.

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This, however, is rarely the case in this practice and the presence of yellow diarrhœa at once excites a suspicion of coccidial infection.

Although diarrhœa is present and copious there is apparently little or no systemic disturbance since appetite is normal, the eyes remain bright and clear and there is rarely any abdominal pain, provided that the animal is seen within the first few days following the onset of diarrhœa.

After about three days there may be flecks of blood in the fæces and the animal may show signs of abdominal pain, while in more advanced cases still, the amount of blood passed in the faeces may be so great as to arouse the suspicion of a profuse intestinal hæmorrhage.

Only in extremely advanced cases has the temperature been above normal or the pulse affected. The appetite is usually maintained although the animal rapidly loses condition and grows thin if the condition remains untreated.

The condition is more serious in the young animal than in older dogs, since, as stated by Cameron (1934), the destruction of tissue is at a more rapid rate than repair. A puppy may be reduced to a state of emaciation by chronic diarrhœa while the destruction of cells also prevents the full use of food ingested. The response of the young animal to treatment in any form is far from good, a point borne out in this practice by records of some fifty cases in young puppies.

Transmission

Animals are infected by ingestion of contaminated material containing oöcysts. This, however, is not the complete story. The dog is usually particular about the condition of the feet and licking of paws is a method of transmission which must not be disregarded since the feet may become contaminated while at exercise. The life cycle is direct, i.e., no intermediate host is required, and so an infected animal may re-infect itself.

One further and important point must be taken into consideration when dealing with transmission, namely, " carrier " animals. Cameron states that symptoms may be absent until some condition arises to cause debility. Thus the condition has been seen to arise suddenly in an animal which has become chilled, been debilitated by indiscriminate worming or been the subject of some ailment.

Incidence

The incidence of the condition would appear to be very general, in that animals of all ages have been treated for the disease. It should be noted that the young appear to be more susceptible than older dogs and where the condition occurs in kennels the spread among young puppies is rapid, while the older dogs remain unaffected.

The incidence seems to have no relation to sex, nor would one breed seem to be more prone to the condition than another.

No general census of incidence has been possible but it would appear that in this practice about 5 per cent of the cases of diarrhœa examined during a twelve-month period are affected with coccidiosis, but diagnosis is based mainly on symptomatology and subsequent response to specific forms of treatment. However, in those cases in which microscopic examination has been made samples have always proved positive.

Mortality Rate

The mortality resulting from this condition is very low and probably in the region of 1 per cent among older dogs and then only in animals which have remained untreated for a considerable time or where there has been improper co-operation on the part of the owner. In young puppies, however, and particularly in kennels where there were many young animals in close proximity mortality was as high as 50 to 60 per cent of puppies between the ages of six weeks and five months.

Discussion

From the foregoing pages it will be seen that, while the incidence of coccidiosis in canines would appear to be relatively high, it is not necessarily a dangerous condition except in so far as it may produce debility and loss of resistance, thus opening up the way to infection by more dangerous things such a distemper and hard pad. It has been noted that the condition itself would appear to have serious effects only when the patient's general resistance is lowered. It may, therefore, be regarded as either a forerunner or successor to other disease.

In the young puppy coccidiosis should be regarded as a serious matter and every effort should be made to keep the tissues of these young creatures in a healthy state.

The most efficient method of preventing the disease lies in the application of measures of hygiene, namely the swabbing of the feet after exercise and the anal region after defæcation with a mild antiseptic solution. Unfortunately the average dog owner regards such measures as a nuisance or a fad and does not follow the advice given. Cleansing of gardens and paths of fæcal matter would, of course, help to reduce incidence of the disease.

Summary

Short mention is made of the species of Coccidia affecting dogs and a summary of the life-cycle of Coccidia is given.

The symptoms as observed in this practice are described and mention is made of the methods of transmission.

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The incidence as related to breed, sex and age is discussed and mention is made of the mortality rate.

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THE IMMUNITY TO *CL. CHAUVŒI* PRODUCED BY VACCINE PREPARED FROM CELLOPHANE SAC CULTURES

By P. W. THOROLD

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It has been shown by Polson and Sterne (1946) and Sterne and Wentzel (1950) that high-titre botulinus toxin can be obtained from dialysate cultures grown in cellophane membranes. Subsequently, Sterne, Thorold and Scheuber (1951) have reported the adaptation of this method of culture to the production of chauvœi vaccines. More recently, Fredette and Vinet (1952) have successfully used this technique for the production of tetanus toxin. Work has been carried out at Kabete which further emphasises the value of this new method of anærobic culture for the production of chauvœi vaccine.

The usual method of assessing the antigenic efficiency of *Cl. chauvœi* vaccine is by animal inoculation and, after a suitable interval, by challenging with virulent culture, or with spore suspensions activated by various tissue irritants (Tenbroeck and Bauer, 1926; Fildes, 1927; Robertson and Felix, 1930). For the routine testing of *Cl. chauvœi* vaccines at these laboratories Merino-type sheep are used which, three weeks after vaccination, must withstand at least 50 m.l.d. of virulent culture.

In addition to using this method for testing the efficiency of experimental batches of vaccine, a rapid slide agglutination test has been developed in an attempt to assess the relative values of the experimental batches by serological means. Reports on the efficiency of serological tests vary (Heller, 1920; Medical Research Council, 1929; McIntosh, 1917), mainly due to the difficulty experienced in producing a stable antigen, but they have been used for the typing of strains (Jungherr, 1928), diagnosis (Meyer, 1915) and demonstration of "H" and "O" agglutinins (Henderson, 1932a).

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Materials and Methods

1. *Preparation of Vaccines*

The methods used in the preparation of concentrated dialysate, its detoxification, dilution and adsorption on to aluminium phosphate ($AlPO_4$) (Holt, 1947) were essentially the same as previously described (Sterne *et al.*, 1951), except that four- and twelve-litre flat-bottomed flasks were used as culture vessels with $2\frac{3}{4}$ in. and 4 in. diameter sausage skin casings (Visking's standard stretch) containing 600 ml. and 2,000 ml. of normal saline respectively.

The following medium adjusted to *pH* 7.4 was found to support almost as good a growth as liver meat broth:—

K_2HPO_4	0.5%	KH_2PO_4	0.1%
Na_2SO_4	0.05%	$CaCl_2$	0.01%
$MgSO_4$	0.005%	$MnSO_4$	0.003%
$FeSO_4$	0.001%	Peptone	2.0%
"Lemco"	1.0%	Commercial cane sugar ...	1.0%
Liver extract	0.5%		

and tap water to 100.

Anaerobiasis was achieved by placing cotton wool in the medium.

The concentrated vaccines were stored at ±4° C. and diluted appropriately for the various experiments.

Adsorption and dilution were effected with 2 per cent $AlPO_4$, and precipitation with 2 per cent alum. The *pH* of vaccines was always adjusted to 6.0.

All vaccines were inoculated subcutaneously.

2. *Challenge Inoculations*

These consisted of the intramuscular inoculation of a 24-hour von Hibler culture of virulent *Cl. chauvœi* organisms in amounts containing not less than 50 m.l.d.

Experiment I: The Effect of Diluting Concentrated Vaccine

Sheep were inoculated with various dilutions and challenged 21 days later (Table 1).

TABLE 1

Vaccine dilution	Dose ml.	No. of sheep	Challenge	Result
Concentrated	5.0	3	1,000 m.l.d.	2S 1D
„	1.0	5	500 „	4S 1D
1/50	1.0	8	300 „	8S
1/100	1.0	8	300 „	8S
1/200	1.0	8	200 „	8S
1/400	1.0	8	200 „	6S 2D

NOTE.—In this and subsequent tables: S = survived; D = died.

Experiment II: The Effect of Reducing the Dose

Sheep given various doses of vaccine diluted 1/25 were challenged after three weeks (Table 2).

TABLE 2

Dose ml.	No. of sheep	Challenge	Result
1.0	2	100 m.l.d.	2S
0.5	2	50 „	2S
0.1	2	50 „	2S

Experiment III: The Effect of Storage

Concentrated vaccine was (*a*) stored at ±4° C. for 12 months, then diluted 1/25; (*b*) stored at ±22° C. for twelve months; (*c*) diluted 1/50 and 1/100 and stored at ±22° C. for twelve months; and (*d*) lyophilised, stored at ±4° C. for twelve months, then reconstituted and diluted 1/25. Sheep were given 1.0 ml. in each case and challenged three weeks later (Table 3).

TABLE 3

Storage method	Vaccine dilutions	No. of sheep	Challenge	Result
Concentrated vaccine at ±4° C. for 12 months	1/25	4	100 m.l.d.	4S
Concentrated vaccine at ±22° C. for 12 months	Undiluted	2	100 „	2S
Diluted vaccine at ±22° C. for 12 months	1/50	2	100 „	2S
	1/100	2	100 „	2S
Lyophilised vaccine at ±4° C. for 12 months	1/25	4	100 „	4S

Experiment IV: Adsorption followed by Precipitation

Concentrated vaccine was (*a*) diluted 1/25 with $AlPO_4$, and (*b*) diluted 1/25 with normal saline and then precipitated with 2 per cent alum. Sheep were given 1.0 c.c. of each product and challenged three weeks later (Table 4).

TABLE 4

Vaccine	No. of sheep	Challenge	Result
$AlPO_4$ adsorbed	4	100 m.l.d.	4S
Precipitated with 2% alum	4	100 „	1S 3D

Experiment V: Duration of Immunity

Sheep were given (*a*) concentrated vaccine diluted 1/25, and (*b*) Kabete stock alum-precipitated whole culture vaccine (Piercy, 1951). Immunity was challenged at six-, twelve- and fifteen-month intervals (Table 5).

TABLE 5

Vaccine	Dilution	Dose ml.	No. of sheep	Challenge 50 m.l.d.				Result	
$AlPO_4$	1/25	1.0	15	6 months		2 sheep		2S	
adsorbed				12	„	3	„	3S	
				15	„	3	„	3S	
Kabete	undil.	2.0	6	6	„	2	„	1S	1D
stock				12	„	2	„	1S	1D
vaccine				15	„	2	„		2D

Experiment VI: Field Test in Cattle

Five hundred head of Zebu cattle from seven field stations were inoculated subcutaneously with 2.0 ml. of a 1/25 dilution of concentrated vaccine. Ages of the cattle ranged from 4 to 25 months and none had been inoculated previously against blackquarter. No marked swellings were noted at inoculation sites nor any rise in temperature. Nodules persisted in some animals up to four to six months after inoculation. One month following inoculation two animals from each station, making fourteen in all, were challenged with 200 m.l.d.—all survived.

A further test with a reduced dosage was done in European grade cattle. They were given 1.0 ml. only of vaccine and challenged with 100 m.l.d. three weeks later—all survived.

Evaluation of Vaccines by Slide Agglutination

The slide method was chosen for simplicity, small amounts of reagents required, and rapidity with which results are obtained. It was hoped that the test would indicate the relative ability of different vaccines to stimulate antibody production.

Method

Organisms from a three- to four-day dialysate culture were washed three times in normal saline then suspended in twice their volume of 5 per cent normal saline and stored at ±4° C. For the test the concentrated antigen was diluted in normal saline to No. 7 Brown's opacity tube. On a clean slide one drop of the test serum and one drop of antigen were mixed and the result read against a dark background with a 5x hand lens. A normal saline control was always included. Agglutination occurred within one to two minutes. The antigen appeared to keep for at least six months. Antigens made from different strains were standardised against a hyperimmune serum. A local strain which did not sporulate readily in the medium used was chosen for most of this work.

Pure suspensions of organisms were also obtained by seeding on to a cellophane disc placed on the surface of a liver-blood-agar plate. This method is useful for obtaining material for testing enzymes such as hæmolysins and coagulases (Thorold, 1952, unpublished).

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Results

Table 6 shows the agglutination titres of the sera of sheep inoculated with various types of vaccines.

TABLE 6

Vaccine	Dose ml.	No. of sheep	Titre Ranges: Prior to inoculation	21 days	Post-inoculation 6 mths.	12 mths.	15 mths.
Concentrated dialysate	1.0	10	0-1/10	1/10-1/1,000	N.D.	N.D.	N.D.
$AlPO_4$ adsorbed diluted 1/25	1.0	45	0-1/10	1/200-1/1,000	N.D.	N.D.	N.D.
$AlPO_4$ adsorbed diluted 1/25	1.0	15	0-1/10	1/20-1/400	1/50-1/100	1/30-1/100	1/30-1/100
Kabete stock vaccine	2.0	15	0-1/10	1/70-1/150	1/10-1/30	<1/10	<1/10

NOTE: N.D. = not done.

There was a marked individual response as shown by the range of titres in the above table; of interest in the first group inoculated with concentrated dialysate is that four sheep failed to respond with titres greater than 1/10. In each case the response to $AlPO_4$ adsorbed antigen was greater than that to alum-precipitated stock culture vaccine and the immunity appeared to persist for a longer period. Scheuber (1944) found that the immunity to alum-precipitated culture vaccine waned after six to twelve months.

According to the work of Green (1929), Henderson (1932) and Mason (1936) the bacillary body and products of its autolysis constitute the important antigen. These workers proved that a suspension of washed and formalised or boiled bacilli free of aggressin or toxoid is a good antigen. Table 7 shows the agglutinin response in sheep to inoculation with washed bacilli, toxoid, toxoid and bacilli and boiled toxoid. An actively growing three-day dialysate culture was used. The organisms were spun out, washed three times in normal saline, suspended in twice their volume of normal saline and 0.5 per cent formalin added. The supernate from the dialysate culture was passed through a Seitz filter and 0.3 per cent formalin added to a portion of the filtrate, the remainder being boiled for thirty minutes.

TABLE 7

Antigen	Dose ml.	No. of sheep	Titres Pre-inoc.	Post-inoc.
Bacilli	2.5	3	<1/10	1/900
			<1/10	1/1,000
			1/10	1/1,000
Toxoid	2.5	3	1/10	1/30
			<1/10	1/10
			<1/10	1/20
Bacilli + toxoid ...	5.0	3	1/10	1/1,000
			<1/10	1/1,000
			<1/10	1/900
Boiled toxoid ...	2.5	3	<1/10	<1/10
			<1/10	<1/10
			1/10	1/10

As was expected, a high titre was obtained with the bacilli alone and this was not enhanced by the addition of toxoid whereas with toxoid alone the titre was negligible.

In a further experiment sera for the agglutination test were taken from 120 head of cattle used in the field test described in experiment VI. Pre-inoculation titres of 24 calves 4 to 9 months old ranged from 0-1/30; the remaining animals had all been weaned and their titres ranged from 0-1/10. One month after inoculation titres ranged from 1/40-1/1,000 and at four months from 1/20-1/100 with the exception of three animals from one particular station (Table 8).

TABLE 8

Bovine No.	Serum Agglutination Titres Pre-inoc.	P.I. 1 month	P.I. 4 months
325	1/10	1/1,000	1/2,000
376	<1/10	1/20	1/60
293	1/10	1/500	1/2,000

It is thought that the marked increase in titre after the first month may have resulted from exposure to natural infection.

Table 9 shows the titre ranges of certain animals from the field test sent to the laboratory for challenge.

TABLE 9

No. of cattle	Titre Ranges 1 month p.i.	Challenged	1 month p.c.
14	1/40-1/900	200 m.l.d.	1/200-1/15,000

The above two tables again bear out the marked variability of individual response to the same antigen, thus reducing the value of the test in cattle and sheep in assessing the antigenicity of different batches of vaccine unless large

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numbers of animals are used. A preliminary test in twelve guinea-pigs all inoculated with the same antigen indicated that the response may be more even, whilst no agglutinins were present in their sera prior to inoculation.

Discussion

Cl. chauvœi occupies a unique place amongst the spore-bearing anaerobes since, unlike *Cl. botulinum, tetani* and *welchii,* it is not a true toxin producer. Some strains do produce a lethal toxin, however (Kerrin, 1934) and filtrates of one Kenya strain kill mice in doses of 0.2 ml. intravenously and guinea-pigs in doses of 0.5 ml. intraperitoneally. Other strains appear to have lost this power (Viljoen and Scheuber, 1926). Mason (1936) demonstrated the presence of a toxin and also that there is no relation between the amount of circulating antitoxin and the power of an animal to resist inoculation of viable culture.

For the routine production of vaccine at these laboratories during the last four years a number of different strains have been used varying considerably in virulence (Piercy, 1951). For example, one strain killed guinea-pigs in 36 to 48 hours following inoculation of at least 4 to 5 ml. of a 24-hour culture, whereas another killed in 24 to 30 hours following inoculation of only 0.1 ml. of a similar culture. Vaccine prepared from the low virulence strain protected sheep against the usual 50 m.l.d. challenge. Similarly, a relatively non-pathogenic strain has been used for vaccine production in Southern Rhodesia (cited by Mason, 1936).

Since there is good evidence that immunity to *Cl. chauvœi* is dependent on the "heat stable antigen" of Henderson (1932b), i.e., the bacterial body and products of its autolysis, the cellophane sac method of culture provides a means of obtaining heavy suspensions of bacteria and their products of autolysis in comparatively pure form. The process of detoxication, precipitation or adsorption are, therefore, more efficient than they would be in the presence of large amounts of extraneous protein material as in tissue cultures. To illustrate this point, sterility tests are carried out on each batch of vaccine produced by seeding material into von Hiblers' brain medium after toxoiding. Occasionally growth occurs after one or two weeks' incubation, probably due to isolated spores buried in the mass of tissue and not inactivated. In this respect the sheep is a more sensitive test animal than the guinea-pig.

The use of a simple medium, high yield from a single flask and reduced dosage level significantly lowers production costs, while the advantages of storing the concentrated vaccine in the dry state are obvious.

Summary

Potent anti-chauvœi vaccines can be produced by using cultures from intussuscepted cellophane tubing. Doses of 1 ml. and 2 ml. in sheep and cattle elicit a high degree of protection against a severe challenge. The vaccine can be stored wet or dry for periods up to one year without apparent loss of antigenicity.

The advantages of dialysate vaccine over tissue culture vaccine are discussed. The slide serum-agglutination test appears to be of limited value in cattle and sheep in assessing the relative efficiency of vaccines.

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REVIEWS

THE SURGICAL DISEASES OF THE DOG AND CAT, by Sir Frederick Hobday. Sixth Edition. London: Baillière, Tindall & Cox, Ltd. Price 30s.

IT is a great pleasure to be able to welcome yet another edition of the perennial "Hobday" and to congratulate those responsible for its production on the way the book has been brought up to date.

We have now in "Hobday" an exceedingly valuable collection of notes which indicate the types of surgical intervention which many years of experience have shown can be undertaken in the dog and cat with prospects of success, together with a general description of the methods by which such intervention may safely be brought about. For a book on animal surgery to attempt to do more than this would be most unwise—a large volume giving a detailed and elaborate account of the techniques involved in the various operations and modelled on books of human surgery would almost certainly fail of its purpose because with us virtually no one, outside the schools, can afford to devote the whole of his time to surgery and, moreover, our surgical work depends in a very large measure on the means at our disposal. In human surgery no surgeon would in the normal course of events ever dream of performing an operation

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except in a theatre equipped with every modern appliance and assisted by a thoroughly experienced anæsthetist, qualified assistants and a properly-trained staff. In such cases detailed accounts of technique are matched by the ability to put the instructions into effect. The veterinary surgeon, on the other hand, has very often to bring about his surgical interventions where he can, often under very disadvantageous conditions and almost unassisted. His efforts are limited by economic factors and since he has to deal with irrational patients he is, in spite of the co-operation of the owners, precluded from exerting that absolute control of the patient's behaviour after the operation that is enjoyed by the human surgeon. With this in mind, it is obvious that a book on animal surgery must be general in approach and simple in technique—a hysterectomy described in fifty pages would look odd beside a patient prepared for operation on a simple table. The animal surgeon can never be dictated to; he must always retain the initiative and "Hobday," with its half a century of experience, takes care that that initiative remains unimpaired.

THE BRITISH JOURNAL OF ANIMAL BEHAVIOUR. London: Association for the Study of Animal Behaviour. Baillière, Tindall & Cox, Ltd. Price, £1 7s. 6d. per annum.

VETERINARY SURGEONS should welcome the appearance of this new quarterly. It has a definite bearing on their work and should provide interesting reading also for agriculturalists and stockbreeders who are daily in touch with animals. "The British Journal of Animal Behaviour" is edited jointly by two veterinary surgeons, Alastair N. Worden and B. A. Cross, with the assistance of many well-known personages distinguished in biological research. Produced primarily for the benefit of biological workers, it is hoped that their observations will lead to a general clarification and better understanding of this subject.

Though the average veterinarian is not concerned with the academic aspects of behaviour of animals, as, for example, whether honey bees have memories or the rate at which rabbits feed, yet the results of prolonged study of the grazing behaviour of cattle may give a valuable contribution to veterinary science and it may not be speculating too much to assume that certain conditions of management of animals lead more readily to outbreaks of disease, and that the causes of certain diseases may be discovered through this process of observation.

The various writers anticipate that more economical methods of management beneficial to the health of livestock will be found in this way, and knowledge thus attained will no doubt be utilised by stockowners. While we might wish to restrict these workers to such fields, to do so might undermine the value of their research as no doubt they would assure us that while studying the "Responses of Wild Rats to Offensive Smells and Tastes" (as one article is entitled) they are obtaining just the information needed to supply us with an effective method of keeping these creatures out of our animal houses. A large proportion of the contents of the first two issues of the journal directly concern farm animals.

While commending this publication to those concerned with animal husbandry and veterinary science, it is necessary to make a reservation. One hopes that the Editors will ensure that the material which is published will not be too abstruse and academic and that the practical application of the work will be borne in mind. The medical profession recognises the value of psychological research and its usefulness in practice. The study of instinctive behaviour in the animal creation is of necessity on a somewhat different plane, but in this sphere and to assist him in his many practical problems the veterinary surgeons will profit if they are versed in this science.

THE NATURE OF VIRUS MULTIPLICATION. The Second Symposium of the Society for General Microbiology, edited by Sir Paul Fildes and W. E. van Heyningen. Cambridge: The University Press, 1953. Pp. 320. Price, £1 15s.

IN April, 1952, chemists, physicists, and research workers in medicine, plant pathology, entomology, poultry research, bacteriology and tumours discussed with each other whether there is anything in common between the modes of virus multiplication assumed to operate in their respective spheres. This is a controversial subject and the Committee of the Society for General Microbiology selected it for a symposium and invited a representative group of virus experts to write a full account of their views. These were set up in type and the galley proofs distributed to members of the Society before the meeting; these were taken as read and after brief introductions by the authors the papers were thrown open to invited speakers and the audience generally. This handsome volume contains the edited versions of the contributions made by the selected group of authors, the invited speakers and those in the audience who, having spoken, recorded their share in the discussion.

The Society for General Microbiology was formed for the purpose of advancing the study of microbiology by providing a common meeting ground for those working in the specialised fields. This symposium is one example of the methods used for this purpose and it is illuminating to observe the contrasts yet similarities between those whose initial training leaned to the physical or the biological side of science. Biochemists are eager to know more about virus reproduction because it may lead to a better understanding of the problems of protein synthesis. On the other hand, pathologists take much cognisance of the host and of the necessity for the supply, by the animal or plant host, of the substances required for multiplication of the virus. The disturbance of the host in virus infections is therefore ascribed to the new control of the cytoplasmic activity by a foreign agency.

Plant viruses are relatively uniform in structure, and advantage has been taken of the purification of these viruses to study the composition and relationship of protein and nucleic acid which they contain. The fundamental differences between groups of these viruses are correlated with their nucleic acid composition, whereas strain differences are correlated with their amino-acid composition.

Many speakers had worked with bacteriophage, and it was emphasised that

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the lytic phase of a phage must be regarded as one aspect of a life cycle, albeit the pathogenic one. It may well be that immunity to a virus infection is associated with a lasting symbiotic infection. The views of those working with the neurotropic viruses, the virus infection of insects and the viruses of fowl tumours recorded their particular views and contributed to the whole.

Hypotheses, facts, records of experiments, questions and answers jostle each other and leave behind, not a feeling of bewilderment, but one of advancement towards a fuller understanding of many things which puzzle those who study natural phenomena. This is the second symposium published by the Society—the first is on "The Nature of the Bacterial Surface"; the third on "Adaptation in Micro-organisms" should be on sale in the autumn. For those who wish to learn the current trend of scientific thought about viruses and their more fundamental attributes should read, refer to and think of the contributions made by 45 scientists at the Symposium held at Oxford University in April, 1952.

NOTICES

THE name of Allen & Hanburys, Ltd., has been a household one in the field of human medicine and surgery for many years, their reputation having been built upon the quality of their products. In the past they have not been prominent in the veterinary field; we understand that they are now going to enter this field as many of their products can be used with advantage by veterinary surgeons. We welcome this new approach from an old firm of such high reputation.

MEDICAL SICKNESS FINANCE CORPORATION, LTD.

AT the Annual General Meeting of the Medical Sickness Finance Corporation, Ltd., held at 7 Cavendish Square on June 9, 1953, it was reported that during 1952, 875 hire-purchase agreements were entered into for a total of £387,809. The majority of these were for cars but a number were for equipment and miscellaneous items.

The Corporation is a subsidiary of the Medical Sickness Society and although its business is primarily with the medical and dental professions it is prepared to extend facilities to allied professions including veterinary surgeons. The terms offered are extremely favourable.

Publishers' Notices

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